The RGP SuperFit: A computer-assisted approach to rigid gas permeable contact lens fitting

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Abstract
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The RGP SuperFit:
A Computer-Assisted Approach to Rigid Gas Permeable Contact Lens Fitting

by

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and
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Edward M. Bennet, OD, MSED
Patrick J. Caroline, COT, FAAO
Introduction

The RGP SuperFit was originally conceived as a computer program able to quickly handle the tedious task of calculating numerous parameters of a rigid gas permeable contact lens. The primary goal was to develop an easy to manage, user-friendly device. Once the initial plans were laid, the project eventually ballooned into a clinical tool, designed not merely to provide RGP calculations, but display the fit graphically as well. The graphical nature of the SuperFit lends itself as a teaching tool, detailing numerous spherical RGP fitting scenarios quickly and easily. The RGP SuperFit was written in Visual Basic 5.0; the SuperFit requires an IBM-compatible PC (386 or above; Pentium recommended for graphical use).

The Program

Set-Up

Within the Set-Up option are a number of settings allowing the user to define aspects of lens fit such as Axial Edge Lift or Corneal Eccentricity, as well as default settings making trial lens fitting more convenient.

Default Diameters - This allows personal lens design, and is helpful in trial-lens situations where a given trial set has a constant diameter or optical zone for any given lens. Here, the calculated lens is designed from these pre-set parameters, rather than (or in addition to) calculations based on Central K’s. In situations where a good fit cannot be accomplished with the designated default value, this option is automatically over-ridden.
Physiological Parameters - These settings are not extremely vital to lens design, but the program will check this data and warn the practitioner when the pupil diameter encroaches on the optical zone, causing flare, etc.

First Aid - The AEC Auto-Correct automatically sets the Axial Edge Clearance at 0.08 mm along the flat K, after the user has modified the originally-calculated lens (more on AEC later). The Contact Lens Auto-Advice feature is designed to provide fitting advice during lens modification; this feature is not yet completed.

Profile Settings - Here, the user can choose a pre-set amount of corneal eccentricity in situations where only the central 3.0 mm of the cornea is measured, i.e., standard keratometry. Eccentricity is given in both p-value (unity = 1.00) and e-value (unity = 0). The general consensus among researchers is an average p-value of 0.8 among the general population, although this can vary considerably between individuals (Douthwaite, 1995). Of course, auto-keratometers that utilize peripheral measurements and return an eccentricity value will work well with this option.

Tear Layer Thickness is used to define the amount of clearance between the lens and corneal apex in a clearance fit, and is pre-set at the “optimum” value of 0.015 mm (Bibby, 1976). Axial Edge Lift, perhaps the most important parameter used in RGP fitting, defines “the distance between the surface of the peripheral curve and the point in space where the base curve would be if it continued uninterrupted” (Schwartz, 1997). Finally, an “on-off” switch is provided for users with slower computers who do not wish to wait for the Fluorescein Map completion time, or are satisfied with the tear layer profile graphics alone.

Lens Design - This simply gives the user the choice of calculating a 3- or 4-curve lens (Note: some lenses will automatically be calculated as either 3- or 4-curve lenses based on peripheral curve width/optical zone diameter ratios).

Auxiliary Settings - More “convenience” features are provided here: when the Peripheral K Setting switch is in the “on” position, the PK screen is automatically opened at the beginning of each lens fit. The Central and Peripheral Diameter(s) are pre-set for use with a modified Bausch and Lomb Keratometer, based on work done by Lam and Douthwaite (1994). Further clinical research is necessary determine default values for any given topographical keratometer. The Factor Spectacle Rx module has not been written into the program at this time.
Peripheral K’s

The Peripheral Keratometry module is based on the “current program” devised by Douthwaite and Lam, as mentioned previously. These researchers derived a formula that uses central and peripheral K readings to produce a measurement of peripheral corneal flattening. In their study, Douthwaite and Lam used a modified B&L keratometer; further research in this area is necessary to determine the best method of measurement using any keratometer (thereby eliminating the need for expensive corneal topographers in most RGP fitting situations). Although measurements using the Peripheral K module return variables as p-values, these are automatically converted to eccentricity values on the main screen.

The Main Screen

The simplicity of this program is most evident on the main screen. The only required parameters necessary to calculate a lens are Central K’s. A Spectacle Rx must be entered (either on the Main Screen, or in the Calculate Rx module) to complete the lens Rx and over-refraction.

The basic instructions for calculating an RGP includes these 3 steps:

1. Input Horizontal K values
2. Input Vertical K values
3. Select a lens design (Alignment or Clearance Fit)

Spectacle Rx - Simply enter the spectacle refraction. If there is no cylinder in the spectacle refraction, the cyl and axis boxes may be left blank. Cylinder form can be converted to (+) or (-) form by clicking on the colored box between the sphere and cylinder value.

Alignment Fit - This method of calculation takes Pat Caroline and Craig Norman’s *alignment fitting philosophy* (1988) to a higher level of precision. The *alignment fitting philosophy* is built on the premise of fitting the lens along the flattest meridian, increasing the base curve radius by -0.50 D to allow for peripheral corneal flattening, thereby creating a horizontal fulcrum. Here,
this philosophy is taken a step further: a “flat fit” is produced by calculating the sags of both the cornea (corrected for peripheral flattening via the p-value) and the contact lens over a specified optical zone diameter. This results in an equivalent sphere at the apex, producing a 3-point touch; the contact lens is thus supported over a wide area, minimizing local pressure on the cornea (Douthwaite, 1995). It has been shown that this method is most successfully fit on corneas with “with-the-rule” astigmatism.

**Clearance Fit** - This method also uses the equivalent sphere approach, with the additional parameter of a pre-determined Tear Layer Clearance (see **Set Up**). Some authors prefer this method of fitting to the alignment method since trauma to the central cornea is minimized; however, there is some controversy about peripheral corneal degeneration (Zadnik, 1994). In theory, this fit method works well on “with-the-rule” corneas, and is likely the better option on corneas with minimal or “against-the-rule” astigmatism.

**Toric Fit** - This module was not included on the RGP SuperFit project, and is not available at this time.

**Modify** - Scroll bars have been provided for cases where the user decides to change any given parameter of a calculated lens. Once the lens has been modified, the user has the option of “correcting” the lens with the Modify command. This allows the maintenance of the OZD equivalent sphere and “optimal” 0.08 mm AEC.

**Curve Calculations** - This might be the most important parameter in RGP fitting. The secondary and peripheral curves on either the Alignment or Clearance Fit are calculated by the specified Axial Edge Lift (see Set Up). The values returned by these calculations include Axial Edge Clearance (AEC), as well as the radii of the secondary and peripheral curves. AEC is a measurement of axial tear depth beneath the peripheral edge of the lens. Radial Edge Clearance values, which give the minimum tear layer thickness, are also provided by the program for comparison. Numerous researchers have found the optimal AEC to be about 0.08 mm. These calculations are made via the step-by-step approach formulated by Rabbetts (Douthwaite, 1995).

Important: All calculations and graphical representations presume a fit centered on the corneal apex.

**Tear Layer Profile**
**Fluid Lens Profile** - The fluid lens profile is a graphical representation of the tear layer depth between the lens and cornea at the flattest and steepest meridians. Although there is no “grid” provided to show the specific depth at any point on the lens, these values can be found by simply moving the cursor to any desired position within the fluid profile area.

**Lens/Cornea Interface** - Another graphical representation showing the relationship of the entire cornea/lens at the flattest and steepest meridians. These profiles offer the user instant graphical representations as different lens parameters are modified.

**Fluorescein Pattern** - This option gives a frontal/axial view of the tear depth throughout the lens. The fluorescein pattern is very similar to that provided by corneal topographers; however, certain assumptions are made here, since all calculations are derived from the steep and flat meridians. This option is not recommended for use on pre-Pentium machines due to the length of time required for all calculations and color plotting (average e.t. = 28 seconds on a typical P-75 computer).

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**Rx Calculations**

*Spectacle Refraction* - The spec Rx is carried over from the main screen. If the user fails to enter a spec Rx on the main screen, it can be entered here. *Vertex Distance* is also user-defined, pre-set at 12 mm. *Material Index* can be adjusted according to the material of the desired RGP. *Center Thickness* is also user-defined, although the program will automatically adjust CT according to *Spectacle Refraction*. The *Back Vertex Power* and *Front Vertex Power* are calculated from these variables, as well as the fluid lens created by differences in the RGP and corneal curvatures.

*Over-Refraction* - This module gives the “expected” over-refraction, based on the properties of the trial lens, including: *Back Vertex Power*, *Center Thickness*, *Material Index*, and *Base Curve*, as well as tear layer differences between the two lenses. Errors induced during clinical over-refractions when the trial lens power is significantly different than the desired BVP are eliminated by correction factors that take into account the vertex distance magnification effects of high-power lenses (Douthwaite, 1995).
Other Options

*Patient Data* - Patient’s name and all relevant lens data can be saved onto the hard drive for later retrieval. At this time, a file directory has not been written into the program.

*Print* - The *Main Screen* can be printed. Although this is a good way to retrieve graphical data in hard copy form, practical clinical use is limited.

**Conclusion**

With the completion of this project, there remains several possible avenues for further research. The next step involves using the program in clinical studies to determine its efficacy, especially compared to empirical methods, trial-fits, and corneal topography. As a teaching device, this program will allow quick verification of calculations, as well as providing a comparison to other fitting methods. For further information on contact lens design, work by Douthwaite (1995) and Rabbets (1993) are highly recommended.
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